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(71) Applicant
The BOC Group plc (United Kingdom),
Chertsey Road, Windlesham, Surrey, GU20 6HJ

(72) Inventor
Henryk Wycliffe

(74) Agent and/or address for service
Dr. George Renton, The BOC Group plc, Chertsey Road, Windlesham, Surrey GU20 6HJ

(54) Dealing with leakage between pump stages

(57) A mechanical pump has at least two stages 10, 11, 12 each comprising intermeshing rotors within a pumping chamber, the rotors being mounted on shafts 3 which pass through and which are dry journaled within walls 8, 9 partitioning one chamber from the adjacent chamber, duct means 51, 52 being provided for transferring gas entering the annular seal between a shaft and the journal for the shaft at a relatively higher pressure region of the pump to a relatively lower pressure region 22 of the pump. The rotors of the stage 10 may be of the Roots type and the rotors of the stages 11 and 12 may be of the intermeshing claw type.

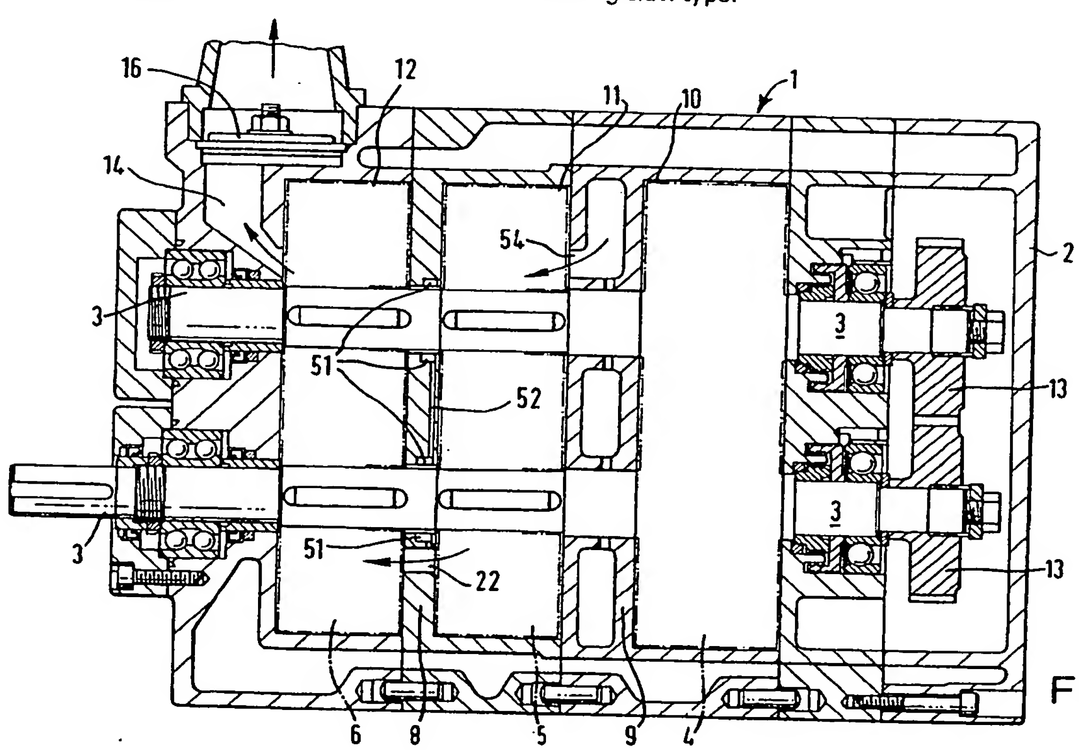

FIG.1

The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

GB 2 175 956 A

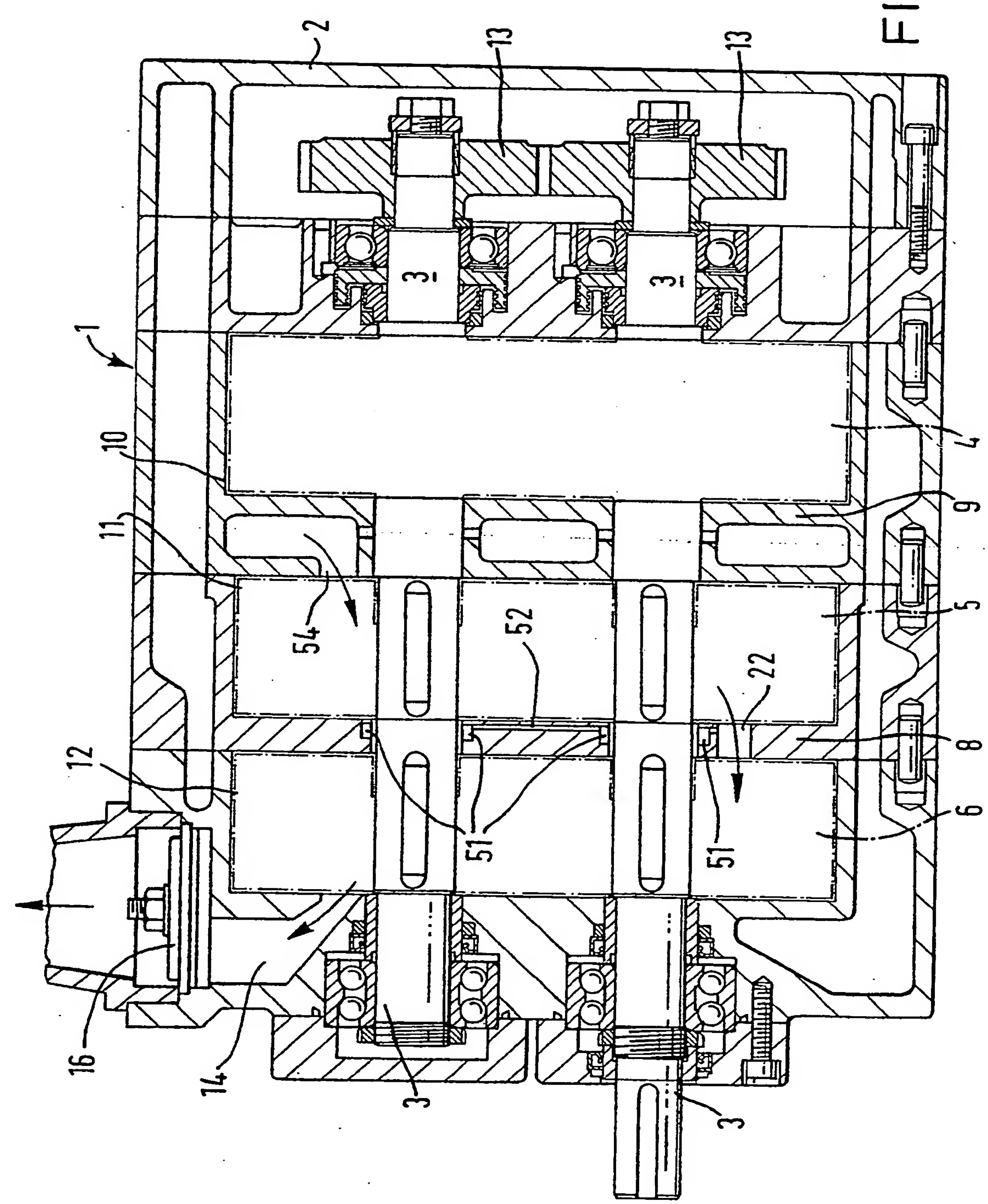

FIG.1

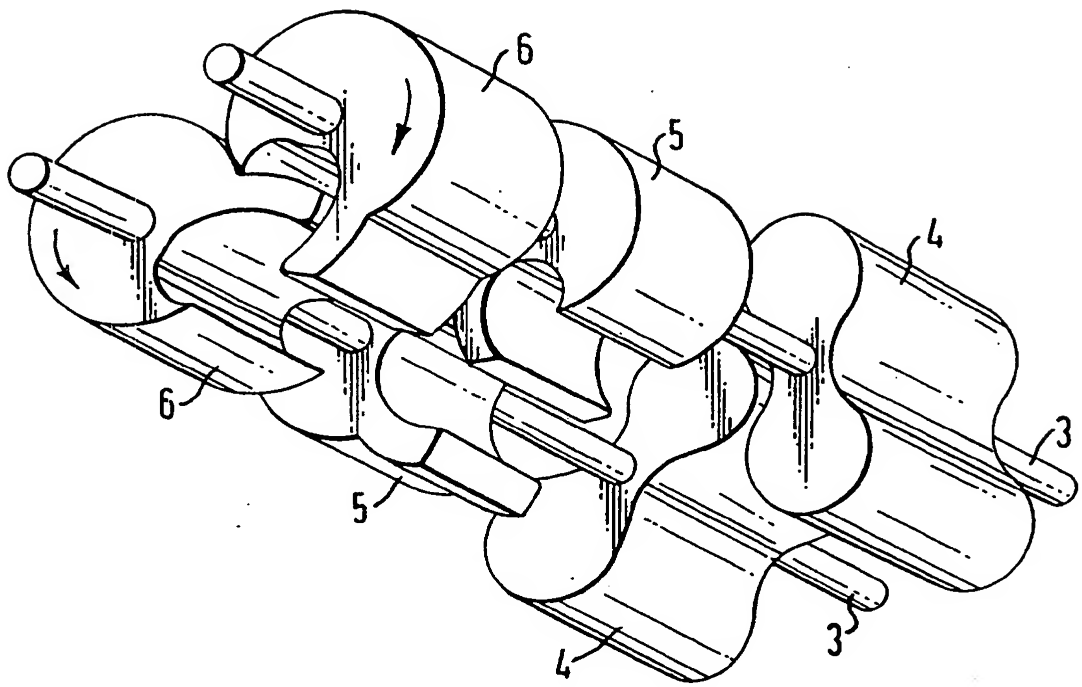

FIG.2.

SPECIFICATION

Improvements in mechanical pumps

This invention relates to oil-free mechanical pumps and is directed to such mechanical pumps having at least two stages each comprising intermeshing rotors within a pumping chamber.

One problem with such mechanical pumps arises from the significant differences in gas pressure which can arise between adjacent stage.

In such a case an enhanced incidence of back leakage of pumped gas is likely to occur between stages; in particular such enhanced incidence of back leakage is likely to occur through the annular gap between the drive shafts and the bore in the inner stage wall which partitions adjacent pumping chambers.

The back leakage of gas through any such gap in the inner stage wall or elsewhere will effectively produce gas counterflow from the pump outlet to the pump inlet, will effectively increase the volume of gas to be re-pumped and will significantly reduce the volumetric efficiency of the pump or attainable vacuum.

In our co-pending patent application No. 2 111 126 A there is disclosed and claimed a mechanical vacuum pump with a plurality of pumping stages each comprising intermeshing rotors within an independent pumping chamber. The pump of this prior application is characterised by the absence of internal lubrication and by at least two adjacent stages at the outlet end of the pump having rotors of the intermeshing claw type.

The relatively high compression of gas produced coupled with the absence of internal lubricant in the inter annular gap further increases the incidence of back leakage.

It is accordingly one object of the present invention is to attempt to reduce the adverse affect such back leakage has on attainable vacuum particularly in dry mechanical pumps.

The present invention according to its broadest aspect provides a mechanical pump having at least two stages each comprising intermeshing rotors within a pumping chamber, the rotors being mounted on shafts which pass through walls partitioning one chamber from the adjacent chamber, duct means being provided for transferring gas entering the annular space between a shaft and a journal for the shaft in a partition at a relatively high pressure region of the pump to a relatively low pressure region of the pump.

In a preferred embodiment of the invention the duct means are arranged to transfer gas from the annular gap at the higher pressure region of a pumping chamber to a lower pressure region of the same chamber.

The invention of this case displays particular advantages when embodied in mechanical vacuum pumps of the type disclosed and claimed in our co-pending application no. 2 111 126 in which two adjacent pumping stages at the outlet of the pump respectively have intermeshing pairs of claw type rotors that are mounted in reverse orientation.

Suitably, the duct means comprise an annular channel provided at and ideally within the inter-stage partition wall, the channel wholly or partly circumscribing the shaft and communicating with a relatively lower pressure region of the pump.

Conveniently the duct, in one stage of the pump, communicates with a similar annular channel provided within a partition wall at a relatively lower pressure region of the same stage and to the inlet of that stage. Thus any leakage of gas instead of entering the inlet side of the preceding stage is short circuited back to the inlet side of the stage from which it came.

An embodiment of the invention will now be particularly described by way of example with reference to the accompanying drawings in which:

Figure 1 is a sectional side view of a dry mechanical vacuum pump having three chambers each containing a pair of intermeshing rotors and;

Figure 2 is a perspective side view of the rotors embodied in the pump of Figure 1.

Referring now to Figure 1 of the drawings, the mechanical pump indicated generally at 1 includes a pump housing 2 through which pass a pair of parallel drive shafts 3. The shafts 3 support for rotation therewith, three pairs of rotors 4, 5 and 6. The rotors 4, 5 and 6 as illustrated more clearly in Figure 2 are arranged in complimentary intermeshing pairs and in tandum on their respective shafts 3.

Referring back to Figure 1, the pump housing 2 is, as shown, divided by partition walls 8 and 9 into three spaced and independent pumping chambers 10, 11 and 12 with each chamber embodying a pair of intermeshing rotors to produce pumping of gas.

At one end of the pump housing each of the shafts 3 carries a timing gear while at the other end of the housing one of the shafts is driveable by being connected to a motor by way of a suitable coupling (not shown) of the type well known in the art.

As will be seen from Figure 2, the intermeshing pair of rotors 4 within pumping chamber 10 are of the Roots type, well known in the art and form part of the first high vacuum or inlet stage of the multi-stage pump 1.

The profile of the roots 4 are adapted to provide minimal carry over volume of pumped gas. By this is meant that the profiles of the co-operating rotors 4 are such that during their interaction the volume of gas trapped on the exhaust side of the rotors, which is carried back to the inlet side of the rotors, is kept to a practical minimum. Any gas carried over from the exhaust to the inlet side of the chamber 10 will tend to expand and will reduce the volumetric efficiency of the pump.

Gas exhausted from the pumping chamber 10 enters the inlet pumping chamber 11 by way of suitable ducting provided in wall 9 which forms the partition between pumping chambers 10 and 11 and which terminates in chamber 11 at inlet port 54.

Referring again to Figure 1, the rotors 5 within the pumping chamber 11 are of the intermeshing claw type also well known in the art. Gas entering the intermediate pressure chamber 11 at the inlet port

54 is pumped to the outlet port 22 which is provided in wall 8 forming the partition between pumping chambers 11 and 12 and which acts also as the inlet port of the pumping chamber 12. While not shown in the drawings, the inlet and outlet ports of the pumping chambers are in the form of arcuate slots.

Gas entering the relatively high pressure pumping chamber 12 is pumped by the intermeshing pair of rotors 6 to the exhaust port 14 of the chamber and to atmosphere preferably but not necessarily; by way of a one way valve 16 effective to improve pumping efficiency in the manner disclosed and claimed in our co-pending application no. 2 111 126 A.

In the case where the pump illustrated is a dry pump, that is to say a pump containing no provision for internal fluid communication, gas compressed by the pair of intermeshing rotors 6 within pumping chamber 12 will tend to leak back into pumping chamber 11, predominantly through the annular gaps between the shafts 3 and the bores in the partition walls 8 and 9.

Such back leakage of gas will particularly effect volumetric pumping efficiency, since in view of the reverse orientation of pairs of rotors 5 and 6, such gas will expand into the inlet side of pumping chamber 11.

To ameliorate the effects of this back leakage, partition wall 8 is, as illustrated in Figure 1, provided at the region of the shaft with circumferentially continuous channels 51. Channels 51 communicate with each other by way of a duct or bore 52 also provided in partition wall 8 and with the transfer port 22.

In operation of the pump, and with gas being pumped from the low pressure to the high pressure end through pumping chambers 10, 11 and 12, gas compressed by the rotors 6 at the highest pressure and outlet end of chamber 12 will tend to leak into pumping chamber 11 through the annular gap in partition wall 8 and in particular through the gap shown at the upper end of the drawing which is nearest the high pressure, delivery side outlet 14.

Instead of leaking into the inlet side of pumping chamber 11, such back leak gas will be trapped by the channel 51, will pass through duct or bore 52 and its co-operating channel 51 and will enter transfer port 22 for re-pumping in chamber 12. The effect of gas diversion through channels 51 and duct 52 is that back leaked gas will be re-cycled only through pumping chamber 12 rather than through both pumping chambers 11 and 12 and will greatly reduce the loss of volumetric pumping efficiency.

It will be appreciated that while this invention has been described with reference to channels 51 provided in the shaft seals between pumping chambers 11 and 12, it can equally be applied to other adjacent pumping chambers and indeed to other regions of the pump where back leakage induces loss of pumping efficiency. It will equally be appreciated that while the invention has been described with reference to a dry vacuum pump it is equally applicable to vacuum or indeed other mechanical pumps having provision for internal lubrication but in which the provision of lubrication is not sufficient to prevent back leakage of gas.

CLAIMS

1. A mechanical pump has at least two stages each comprising intermeshing rotors within a pumping chamber, the rotors being mounted on shafts which pass through and which are dry journaled within walls partitioning one chamber from the adjacent chamber, duct means being provided for transferring gas entering the annular seal between a shaft and the journal for the shaft at a relatively higher pressure region of the pump to a relatively lower pressure region of the pump.

2. A mechanical pump as claimed in claim 1, wherein the duct means are arranged to transfer gas from the shaft seal at the higher pressure region of a pumping chamber to a lower pressure region of the same chamber.

3. A mechanical pump as claimed in claim 2, wherein the duct means are arranged to transfer gas from the shaft seal at the higher pressure region of a pumping chamber to or into the gas inlet port for that chamber.

4. A mechanical pump as claimed in claim 3, wherein duct means are arranged to transfer gas from the seal at the lower pressure region of a pumping chamber to or into the gas inlet port for that chamber.

5. A mechanical pump as claimed in claim 4, wherein the duct means are arranged to produce communication between the shaft seals respectively at the higher and lower pressure regions of the pumping chamber.

6. A mechanical pump as claimed in claim 1, wherein the duct means include an annular channel provided within a pumping chamber partition wall and at least partly circumscribing the shaft.

7. A mechanical pump as claimed in claim 6, wherein the annular channel fully circumscribes the shaft.

8. A mechanical pump as claimed in claim 6 or claim 7, wherein the duct means include a further bore provided in the partition wall and connecting with the annular channel circumscribing the shaft.

9. A mechanical pump as claimed in claim 8, wherein the further bore connects the annular channel circumscribing the shaft seals respectively at the higher and the lower pressure regions of the pumping chamber.

10. A mechanical pump as claimed in claim 9, wherein the further bore communicates with the inlet port of the pumping chamber.

11. A mechanical pump as claimed in any preceding claim, in which the duct means are provided in the pumping chamber at the outlet end of the pump.

12. A mechanical pump as claimed in claim 11, wherein the pumping chamber at the outlet end of the pump encloses rotors of the intermeshing claw.

13. A mechanical pump as claimed in claim 11 or in claim 12, in which the pumping chamber at the

outlet end of the pump exhausts gas through a one way valve.

14. A mechanical pump substantially as herein before described with reference to the accompanying drawings.

15. A mechanical pump substantially as illustrated in and adapted to operate substantially as herein before described with reference to the accompanying drawings.

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